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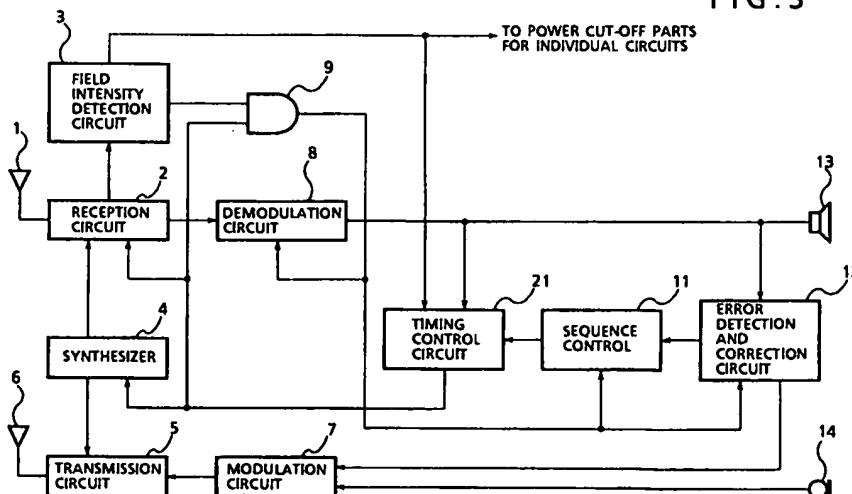
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(54) **Mobile wireless apparatus.**

(57) In a mobile wireless apparatus, electric power consumed at the time of reception standing-by is saved by using intermittent reception or the like because electric power is consumed even in the state of standing-by. It is therefore an object of the present invention to more greatly reduce electric power consumed at the time of intermittent reception. The mobile wireless apparatus according to the

present invention operates to shorten the period of intermittent reception when electric field intensity detected at the time of intermittent reception is weak to thereby avoid wasteful battery consumption caused by the continuation of the receiving operation when the mobile wireless apparatus is out of its service area.

FIG. 3



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BACKGROUND OF THE INVENTION

The present invention relates to a mobile wireless apparatus used in a car telephone, a portable telephone, or the like, and particularly it relates to a mobile wireless apparatus in which electric power consumed in a state of standing-by can be saved.

Fig. 1 shows configuration of a conventional mobile communication apparatus.

As shown in Fig. 1, a conventional mobile wireless apparatus has a reception system constituted by a reception circuit 2 for converting a signal received by a reception antenna 1 into a signal of a predetermined frequency and a predetermined amplitude, a demodulation circuit 8 for demodulating the signal converted by the reception circuit 2 to obtain a base-band signal, and a speaker 13 for reproducing the base-band signal obtained by the demodulation circuit 8. The conventional mobile wireless apparatus further has a control system constituted by an error detection and correction circuit 12 for detecting bit errors in the digital signal in the base-band signal obtained by the demodulation circuit 8 and for correcting the bit errors, a sequence control circuit 11 for controlling connection to a base station on the basis of the output signal from the error detection and correction circuit 12, and a timing control circuit 10 connected to the sequence control circuit 11 and for controlling the timing on the whole of the mobile wireless apparatus. The conventional mobile wireless apparatus further has a transmission system constituted by a modulation circuit 7 which is supplied with a signal obtained by multiplexing an audio signal from a microphone 14 and a signal from the error detection and correction circuit 12, and a transmission circuit 5 for converting the output from the modulation circuit 7 into a signal of a transmission frequency and for transmitting the signal through an antenna 6.

The conventional mobile wireless apparatus further has a synthesizer 4 for selecting a reception frequency and a transmission frequency. The synthesizer 4 is controlled by the timing control circuit 10 and supplies a high-frequency output to both the reception circuit 2 and the transmission circuit 5.

The timing control circuit 10 is connected to the reception circuit 2, the demodulation circuit 8, the sequence control circuit 11, the error detection and correction circuit 12, the synthesizer 4, and the like, in order to perform an intermittent receiving operation and further connected to points necessary for timing control.

The operation of the conventional mobile wireless apparatus having the aforementioned configuration will be described hereunder.

A reception signal received by the antenna 1 is

converted into a signal of a predetermined frequency and a predetermined amplitude in the reception circuit 2 by using the output from the synthesizer 4. The signal of the predetermined frequency and amplitude is led to the demodulation circuit 8, in which a base-band signal is reproduced and sent out as a voice through the speaker 13.

On the other hand, a digital control signal in the base-band signal reproduced by the demodulation circuit 8 is supplied to the sequence control circuit 11 after error correction in the error detection and correction circuit 12. While controlled by the sequence control circuit 11 and the demodulation circuit 8, a timing control signal at the time of intermittent reception of a predetermined interval and at the time of communication as shown in Fig. 2 is generated in the timing control circuit 10.

As shown in Fig. 2, at the time of intermittent reception, the timing control circuit 10 intermittently powers on only the reception circuit 2, the demodulation circuit 8, the sequence control circuit 11, the error detection and correction circuit 12 and the synthesizer 4 as to carry out reception of the control signal.

As shown in Fig. 2, at the time of communication, not only the reception system is operated continuously but a signal obtained by multiplexing an audio signal from the microphone 14 and the digital control signal from the error detection and correction circuit 12 is supplied to the modulation circuit 7 to modulate a carrier wave. After converted into a signal which has a predetermined frequency and predetermined electric power through the transmission circuit 5 by using the output from the synthesizer, the carrier signal is transmitted through the antenna 6.

Electric power consumed in the period of standing-by can be saved even in the conventional mobile wireless apparatus having the aforementioned configuration because the control signal can be received intermittently as shown in Fig. 2.

The conventional mobile wireless apparatus, however, has a problem in that a battery is wasted because the intermittent reception is repeated even in the case where the wireless apparatus is out of its service area, or even in the case where the electric source is left on in spite of the fact that the wireless apparatus is in an unreceivable place such as a basement of an office building.

SUMMARY OF THE INVENTION

An object of the present invention is to reduce consumption of electric power by widening the interval of intermittent reception when electric field intensity is weak.

Another object of the present invention is to attain power saving by widening the interval of

intermittent reception or cutting off the electric source for a long time through detecting bit error of the control signal, when the mobile wireless apparatus is out of its service area at the time of intermittent reception.

In addressing the foregoing objects, according to an aspect of the present invention, there is provided a mobile wireless apparatus comprising: means for intermittently operating a reception circuit at the time of standing-by; means for controlling the interval of the intermittent receiving operation; and means for detecting electric field intensity at the time of intermittent reception, whereby the interval is prolonged when the detected electric field intensity is weak.

According to another aspect of the present invention, there is provided a mobile wireless apparatus comprising: means for intermittently operating a reception circuit at the time of standing-by; means for correcting error of a received signal and for detecting the presence/absence of such a signal that is too weak to be corrected with error; and means for controlling the interval of the intermittent receiving operation in accordance with the presence/absence of the weak signal for error correction, whereby the interval is prolonged when such a weak signal in which error cannot be corrected is present.

According to the present invention, the received electric field intensity is detected while the reception circuit operates intermittently at the time of standing-by, so that the interval of the intermittent receiving operation is prolonged to reduce consumed electric power when the detected electric field intensity is weak.

Further, according to the present invention, the interval of the intermittent receiving operation can be prolonged to reduce consumed electric power in the case where such a weak signal in which error cannot be detected in the received signal is present while the reception circuit operates intermittently at the time of standing-by.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the configuration of a conventional mobile communication apparatus;

Fig. 2 is a timing chart for explaining the intermittent receiving operation in a mobile communication apparatus;

Fig. 3 is a block diagram of a mobile wireless apparatus showing a first embodiment of the present invention;

Fig. 4 is a block diagram of a mobile wireless apparatus showing a second embodiment of the present invention; and

Fig. 5 is an explanatory diagram showing the

change of the interval of intermittent reception in the second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

Fig. 3 is a block diagram of a mobile wireless apparatus showing a first embodiment of the present invention. As shown in Fig. 3, the mobile wireless apparatus in this embodiment has a reception system constituted by a reception circuit 2 for converting a signal received in a reception antenna 1 into a signal of a predetermined frequency and a predetermined amplitude, an electric field intensity detection circuit 3 for detecting electric field intensity received by the reception circuit 2, a demodulation circuit 8 for demodulating the signal converted by the reception circuit 2 to obtain a base-band signal, and a speaker 13 for reproducing the base-band audio signal obtained by the demodulation circuit 8. The mobile wireless apparatus further has a control system constituted by an error detection and correction circuit 12 for correcting bit errors in the digital signal in the base-band signal obtained by the demodulation circuit 8, a sequence control circuit 11 for controlling connection to a base station on the basis of the output signal from the error detection and correction circuit 12, and a timing control circuit 21 connected to the sequence control circuit 11 and provided for controlling the timing on the whole of the mobile wireless apparatus. The mobile wireless apparatus further has a transmission system constituted by a modulation circuit 7 supplied with a signal obtained by multiplexing an audio signal from a microphone 14 and a signal from the error detection and correction circuit 12, and a transmission circuit 5 for converting the output from the modulation circuit 7 into a signal of a transmission frequency and for transmitting the signal through an antenna 6.

The mobile wireless apparatus further has a synthesizer 4 for selecting a reception frequency and a transmission frequency. The synthesizer 4 is controlled by the timing control circuit 21 so as to supply a high-frequency output to both the reception circuit 2 and the transmission circuit 5.

The mobile wireless apparatus further has an AND circuit 9 for obtaining a logical product of the detection output from the electric field intensity detection circuit 3 and the output from the timing control circuit 21. The output from the AND circuit 9 is supplied to the demodulation circuit 8, the sequence control circuit 11 and the error detection and correction circuit 12.

The operation of the mobile wireless apparatus

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having the aforementioned configuration in this embodiment will be described hereunder.

A reception signal received by the antenna 1 is converted into a signal of a predetermined frequency and a predetermined amplitude in the reception circuit 2 by using the output from the synthesizer 4. The signal having the predetermined frequency and amplitude is supplied to the demodulation circuit 8, in which a base-band signal is reproduced and sent out as a voice through the speaker 13.

On the other hand, a digital control signal reproduced by the demodulation circuit 8 is supplied to the sequence control circuit 11 after error is corrected by the error detection and correction circuit 12. Under the control by the sequence control circuit 11 and the demodulation circuit 8, a timing control signal at the time of intermittent reception of a predetermined interval and at the time of communication as shown in Fig. 2 is generated in the timing control circuit 21.

At the time of intermittent reception shown in Fig. 2, the timing control circuit 21 directly intermittently turns on the electric source for the reception circuit 2 and the synthesizer 4 and further indirectly intermittently turns on the electric source for the demodulation circuit 8, the sequence control circuit 11 and the error detection and correction circuit 12 through the AND circuit 9 to thereby perform reception of the control signal.

In the electric field intensity detection circuit 3, electric field intensity at the time of intermittent reception is detected on the basis of the output signal from the reception circuit 2. Two kinds of detection signals, that is, (1) a signal instantaneously detected at the time of intermittent reception and (2) a signal continuously detected, are considered now. The following four procedures are carried out on the basis of the two kinds of signals.

(1) When the electric field intensity detection circuit 3 detects that the electric field intensity at the time of intermittent reception continues weak over a predetermined period, the detection signal is supplied to the timing control circuit 21 so as to enlarge the interval of the intermittent receiving operation.

(2) When the electric field intensity at the time of intermittent reception becomes weak instantaneously, respective electric sources for the error detection and correction circuit 12, the sequence control circuit 11 and the demodulation circuit 8 are cut off at the time of intermittent reception.

(3) The operation of (1) and the operation of (2) are carried out simultaneously.

(4) When the electric field intensity at the time of intermittent reception continues weak, all electric sources are once cut off so that the

mobile wireless apparatus is restarted by turning on an electric source switch without any one of the procedures (1) to (3).

In this embodiment, the following excellent effects are shown by the aforementioned operations:

(1) Because the interval of intermittent reception is prolonged when the electric field intensity detection circuit detects that the electric field intensity at the time of intermittent reception continues weak, consumed electric power can be reduced;

(2) Because the respective electric sources for the error detection and correction circuit 12, the sequence control circuit 11 and the demodulation circuit 8 are cut off at the time of intermittent reception when the electric field intensity becomes instantaneously weak at the time of intermittent reception, consumed electric power can be reduced more greatly; and

(3) Because all the electric sources are cut off so that the mobile wireless apparatus is restarted by turning on the electric source switch when the electric field intensity at the time of intermittent reception is continuously weak, wasteful battery consumption can be prevented in the case where the mobile wireless apparatus is left out of its service area or in the case where the electric source therefor is left on; and so on.

Embodiment 2

Fig. 4 is a block diagram showing the configuration of a second embodiment of the present invention. In Fig. 4, the reference numerals 1, 2, 4 to 8, and 11 to 14 designate parts the same as or equivalent to those in the first embodiment. The reference numeral 15 designates a decoder connected to the demodulation circuit 8 and for reproducing a signal from the demodulation circuit 8 as a voice, and 16 designates an encoder connected to the microphone 14 and for encoding an electric signal from the microphone 14 into a compressed digital signal. The reference numeral 17 designates an error controller connected to the demodulation circuit 8 and having a double function of correcting error in response to a part of the digital output to thereby generate an error correction signal and detecting that such slight error that cannot be corrected is continuously produced for a predetermined period. In this embodiment, a general error detection code (CRC: cyclic redundancy check code) is used for detecting the fact that errors cannot be corrected. The reference numeral 22 designates a timing controller for controlling the timing on the whole of the mobile wireless apparatus on the basis of the output from the sequence controller 11 and the output from the error control-

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ler 17.

The operation of the mobile wireless apparatus in this embodiment at the time of standing-by will be described hereunder. Error is corrected by the error controller 17. When there is any data in which error cannot be corrected, a first signal for reporting incorrectable error is supplied to the timing controller 22 to enlarge the interval for generating a timing signal determining the operation timing on the whole of the mobile wireless apparatus, that is, to enlarge the intermittent reception interval. As shown in Fig. 5, the intermittent reception interval is changed from the ordinary interval t_0 to a longer interval t_1 by the timing controller 22 when the present interval is t_0 and error cannot be corrected. In the case where error cannot be still corrected, the intermittent reception interval is successively prolonged to t_2 , t_3 and t_4 . In Fig. 5, the respective intervals have the relations: $t_0 < t_1 < t_2 < t_3 < t_4$. In the case where error can be corrected, a second signal for reporting correctable error is supplied to the timing controller 22 to shorten the intermittent reception interval in order of $t_4 \rightarrow t_3 \rightarrow t_2 \rightarrow t_1 \rightarrow t_0$. In the case where the present intermittent reception interval is t_4 and error cannot be corrected, or in the case where the present intermittent reception interval is t_0 and error can be corrected, the intermittent reception interval is kept as t_4 or t_0 .

As another error controlling method, the intermittent reception interval may be shortened without feeding of the second signal when error can be corrected.

Although this embodiment has shown the case where the intermittent reception interval is prolonged soon after detecting that error cannot be corrected, the present invention can be applied to the case where the intermittent reception interval may be prolonged after the number of times in reception of the first signal from the error controller 17 into the timing controller 22 reaches a predetermined number or to the case where the intermittent reception interval may be prolonged by the timing controller 22 through the first signal after the error incorrectable state has continued by a predetermined number of times in the error controller 17.

Accordingly, in this embodiment, when such errors that cannot be corrected by the error controller 17 continues for a predetermined period, the mobile wireless apparatus is regarded as being out of its service area to enlarge the intermittent reception interval to thereby more greatly reduce consumed electric power compared with electric power consumed at the time of normal intermittent reception.

When such errors that cannot be corrected by the error controller 17 continues for a predetermined period, the electric source for the whole of the mobile wireless apparatus may be cut off so

that the operation thereof can be restarted by turning on the electric source again. In this case, consumed electric power can be reduced more greatly.

Claims

1. A mobile wireless apparatus comprising:
 - means (2, 4, 8, 11, 12, 21) for intermittently operating a reception circuit (2) at the time of standing-by;
 - means (21) for controlling the interval of the intermittent receiving operation; and
 - means (3) for detecting electric field intensity at the time of intermittent reception; whereby said interval is prolonged when the detected electric field intensity is weak.
2. A mobile wireless apparatus according to Claim 1, wherein electric power is selectively supplied to a circuit (3) related to the detection of electric field intensity at the time of standing-by to thereby operate the circuit.
3. A mobile wireless apparatus according to Claim 1 or 2, wherein the interval of the intermittent receiving operation is prolonged when the electric field intensity at the time of standing-by continues weak for a predetermined time.
4. A mobile wireless apparatus according to any preceding Claim wherein all electric sources are cut off so that the mobile wireless apparatus is started by operating an electric source switch when the electric field intensity at the time of standing-by continues weak for a predetermined time.
5. A mobile wireless apparatus comprising:
 - means (2, 4, 8, 11, 12, 21) for intermittently operating a reception circuit at the time of standing-by;
 - means (12) for correcting error of a received signal and for detecting the presence/absence of such a weak signal in which error cannot be corrected; and
 - means (21) for controlling the interval of the intermittent receiving operation in accordance with the presence/absence of said weak signal.
6. A mobile wireless apparatus comprising:
 - a reception portion (1, 2, 8, 15, 13) for demodulating an original coded digital signal from a received signal and for reproducing a voice from the demodulated signal;
 - a transmission portion (14, 16, 7, 5, 6) for

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converting an analog audio signal into a compressed digital signal and for transmitting the compressed digital signal;

an error controller (17) for detecting/correcting error of the digital signal demodulated in said reception portion in response to a part of the digital signal and for detecting the presence/absence of such errors that cannot be corrected in the digital signal;

a sequence controller (11) for performing line connection to a base station on the basis of the output from said error controller; and

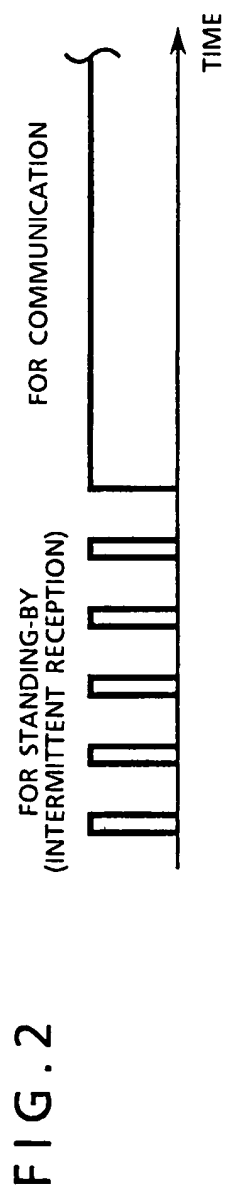
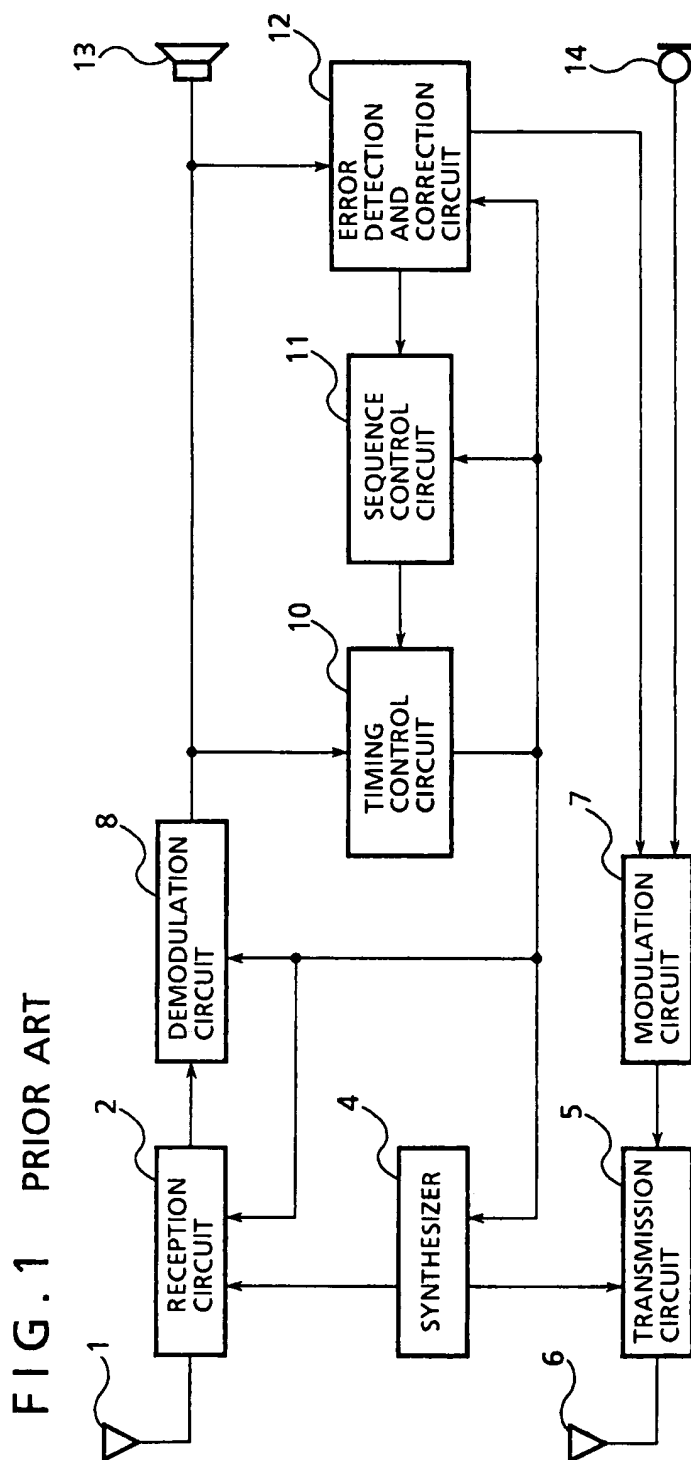
a timing controller (22) for controlling the operating timing on the whole of the mobile wireless apparatus on the basis of the output from said sequence controller and the demodulation output from said reception portion,

whereby the intermittent reception interval generated by said timing controller is changed in accordance with the presence/absence of such a weak digital signal in which error cannot be corrected in said error controller.

7. A mobile wireless apparatus according to Claim 6, wherein said timing controller performs timing control to enlarge the intermittent reception interval when such errors that cannot be corrected in said error controller are continuously detected for a predetermined time at the standing-by time of intermittent reception.

8. A mobile wireless apparatus according to Claim 6, wherein said timing controller performs timing control to cut off the electric source for the whole of the mobile wireless apparatus when such errors that cannot be corrected in said error controller are continuously detected for a predetermined time at the standing-by time of intermittent reception.

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FIG. 3

